

# beaufort

December, 1982



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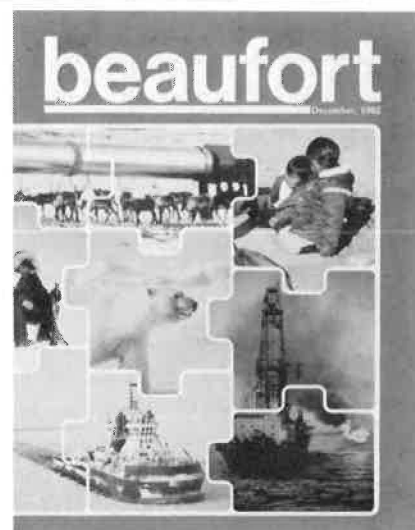
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We would like your views and opinions on the content of Beaufort magazine. Simply drop us a line care of The Editor, Beaufort Magazine, Dome Petroleum Limited,.....

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The cover of the December Issue of Beaufort is intended to depict the pieces of development components, environmental and social elements, all of which can be combined together to form a completed puzzle.

Beaufort is published by Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Inc. to provide the general public, and interested parties, background information on the long range development and production of hydrocarbons from the Beaufort Sea and Mackenzie Delta. In terms of engineering and technical skills production is attainable in this region by the mid-80s. Before approval in principle is obtained from the federal government, a detailed report on the possible effects and impacts of such production must be prepared. This report, known as the Environmental Impact Statement, was completed in the fall of 1982. The E.I.S. addresses issues and concerns raised by the production scenario. BEAUFORT is continuing to report on the progress of the E.I.S. activities and the energy industry's evolving plans.

**Designed and Produced by**  
**Corvus Publishing Group Ltd.**  
**Calgary, Alberta**

# EIS Under Review

Those readers who have been receiving the past editions of **Beaufort Magazine** will know that each of our issues has addressed specific topic areas related to oil exploration and production. With this, our 6th edition, we come full circle back to the subjects addressed in the first edition, that is, the issues and concerns described in the Beaufort Sea Environmental Impact Statement. The magazine was created to explain to the general public and interested parties the story of Beaufort Sea exploration, and the future prospects for oil production and transportation by the three major companies, or proponents, in the region - Dome, Esso and Gulf.

The 2,000 page, seven volume Environmental Impact Statement, supported with 37 additional documents, was completed in October, 1982 and was sent out to the public, special interest groups, appropriate government departments and agencies. On November 10th, Dr. John Tener, Chairman of the Beaufort Sea Environmental Assessment Panel, announced the start of the formal 90-day period for review of the Environmental Impact Statement. During this 90-day period, the Panel will receive written briefs and comments from all interested parties including communities in potentially affected areas. The Panel will also receive technical reviews from federal and territorial government departments with mandates affecting northern development. At the end of the 90 days, the Panel will decide whether or not to accept the EIS as a satisfactory treatment of the major environmental and socio-economic impacts of possible Beaufort Sea hydrocarbon production. This decision will be made in consideration of the advice provided to the Panel by its technical staff and by interested groups, organizations and individuals during the formal



*The Beaufort Sea-Mackenzie Delta Environmental Impact Statement is one of the broadest and encompassing EIS submissions ever prepared by the oil industry. This edition of the Beaufort Magazine examines some of the major issues and concerns addressed in the EIS. Photo by B. Ward.*

review.

Assuming no major deficiencies are identified, public hearings could begin by early March, 1983, during which interested parties including northern communities, environmental organizations, and government agencies will address the issues, concerns and forecast planning of Beaufort Sea and Mackenzie Delta oil production. Following these public meetings the Panel will prepare its report to the federal Minister of the Environment.

This edition of **Beaufort Magazine** will provide our readers with an abridged version of some of the major issues and concerns as examined in the seven volume EIS. Naturally, a 27 page magazine can only barely touch upon some of the topics. The articles written for this edition provide a precis of only some of the more important and sensitive aspects of broad scale development possibilities.

As in the EIS, we have broken the topics down into regions: the coastal and offshore regions of the Beaufort Sea, where ongoing exploration and future production will take place; the Mackenzie Valley, proposed transportation corridor for overland pipelines; and the Northwest Passage, which is forecast as the main traffic route for Arctic icebreaking tankers. Specific activities in these three geographic regions have been addressed in our previous editions and many of our readers will remember our articles on artificial islands, ice research, Arctic icebreaking tankers, pipelines and shorebase systems. We now combine the various components of technology, the environment, and the people into three articles which, in summary format, tell about the future plans and possible implications of oil production in the Beaufort Sea-Mackenzie Delta region.



The Beaufort Sea-Mackenzie Delta region, shown here, has been the site of oil and gas exploration activities for approximately 17 years.

# OIL AND GAS PRODUCTION

## The Beaufort Sea-Mackenzie Delta Region

For approximately 17 years now oil and gas exploration activities have been carried out in the Beaufort Sea-Mackenzie Delta region. During that time, roughly 9 trillion cubic feet (TCF) of gas has been confirmed and about a dozen oil discoveries have been made on-shore and offshore. The most promising oil-bearing geological structures found so far are located

offshore. Their locations are identified by Inuit names such as Tarsiut (night hawk), Kopanoar (snow bird), Issungnak (gull) and Koakoak (raven).

Based on the very encouraging drilling results to date and the fact that more than 90 potential hydrocarbon bearing structures have been identified in the offshore area alone, industry and government

estimate that the region may contain recoverable oil reserves ranging from 6.3 billion barrels (0.9 billion cubic metres) to 32 billion barrels (5.1 billion cubic metres). Even the lower figure represents a substantial amount of oil and would make a major contribution to fulfilling Canada's future demands for oil and its related products.

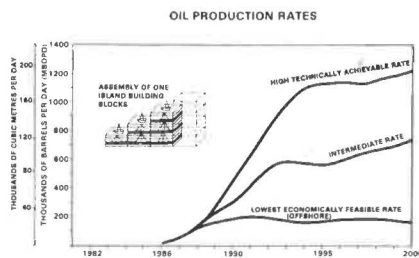
However, discovering oil or gas in

the Arctic is only the first step. After being found, the hydrocarbon reservoirs must be delineated by further drilling in order to prove that commercial reserves exist. This is one of the activities that has been taking place over the past few years at drilling locations such as Tarsiut, Taglu, Parsons, Kopanoar and Adgo. Estimated oil reserves at several of these locations are nearing the threshold quantities needed to proceed with production. For example, even with the somewhat disappointing drilling results of the 1982 step out well on the Tarsiut structure, which found only gas, industry estimates that this reservoir contains approximately 350 million barrels of oil. With appropriate incentives, it could be feasible to begin producing oil from a single island located so that oil wells drilled from this island could reach out to tap a large portion of the reservoir. No matter which field is produced first, whether offshore or onshore, oil production will begin at a low rate. As experience is gained with the production and transportation systems being used, and more oil reserves are proven, the production rate will be increased.

The Environmental Impact Statement prepared by the proponents of Beaufort Sea development examines the technical, environmental and socio-economic implications associated with a range of production rates. Only history will be able to accurately chart the actual production rate which will be tracked by development in this region. But the rate itself will be influenced by a number of factors including government policies, industry's drilling success rate, and social, economic and environmental considerations.

## Basic Requirements for Production

Producing oil from the Beaufort Sea-Mackenzie Delta region on a commercial basis will require a large lead time because several important activities have to be undertaken. They include:



*Oil production in the region will grow in a stepwise fashion as individual islands are completed and begin to produce. The EIS examines the technical, environmental and socio-economic implications of a range of production rates from the highest technically achievable rate down to the lowest economically feasible rate for a single offshore field.*



*Several promising oil and gas discoveries have been made both onshore and in the offshore area.*



*The most promising oil discoveries found to date have been offshore at drillsites such as Tarsiut, Issungnak, Koakoak, and Kopanoar. Here a drillship is seen flaring hydrocarbons during a late season test program.*

1.) One or more reservoirs must be confirmed to contain sufficient oil to be declared commercial - this requires further drilling to delineate present discoveries;

2.) Once an oil field is deemed to be commercial, development structures must be built, production wells drilled and processing facilities installed;

3.) Pipeline gathering systems, to collect well fluids (containing oil, gas and water), both subsea and onland, must be built to gather and transport these fluids to central processing facilities;

4.) A transportation system, using Arctic tankers, overland pipelines, or possibly both, must be in place to transport oil and, at a later time, gas

to markets.

Research, design work, prototype testing, field evaluation, and other actions needed to develop the most feasible combination of components for future oil production in onshore, nearshore, and offshore areas of the Beaufort-Delta region are underway.

Since firm plans still have to be formulated, conducting a thorough environmental and socio-economic review of the range of options under consideration at this time provides an opportunity for the public at large to influence future developments in the region, to ensure that the environment is protected, and to maximize benefits for all Canadians.

The components of future production systems used here will generally be similar to those employed and fully evaluated in other parts of the world including Alberta, the North Sea, the Gulf of Mexico, offshore California, and Alaska, to name but a few. The major challenge in this Arctic region is to adapt this technology to the environment.

The redesign or adaption of proven oil industry systems to suit the Beaufort has focused mainly on the ability of these systems to operate in cold weather, to handle the seasonal ice conditions, and to function safely, with due consideration to environmental protection. This process of adaptation by the oil companies is the result of considerable Arctic operational experience, including the drilling of 135 onshore and offshore wells, the design and operation of an Arctic marine fleet, and the building of 21 artificial islands since 1972.

Impressive technological strides have been made in all areas. For example, the first offshore drilling islands were built with gravel and sand in very shallow water, ranging in depth from 6 to 15 feet (2-5 metres). Most of the earlier islands used weighted slope protection materials such as sandbags to protect their relatively steep upper side slopes from wave and current erosion. By 1976,



*The main components of future production systems used in the Beaufort Sea-Mackenzie Delta region will generally be similar to those employed successfully in other parts of the world including Cook Inlet, Alaska, where the offshore platforms are exposed to first year winter ice and very strong currents.*

sacrificial beach designs were introduced, eventually leading to the construction of Issungnak island, located in 60 feet (20m) of water. At about this water depth, the costs associated with these more conventional construction techniques began to become prohibitive.

To overcome this and other problems, caissons of concrete or steel have been developed. Concrete caissons were first used in the construction of the Tarsiut island which was featured in the November 1981 issue of **Beaufort**. In 1982, the industry brought in two more new caisson-type island designs, one involving a single steel caisson, and the second, comprised of eight steel caissons forming a ring. The single steel caisson, named the SSDC, is presently sitting on a subsea sand berm at a drillsite, where the water is roughly 95 feet (31m) deep. Next year, this same caisson will be moved to another island site, located in a water depth of 140 feet (45 m). As islands were being built further and further offshore, they were also exposed to greater and different ice forces, ranging from the minimal forces found in the stationary landfast ice zone, to the much greater forces generated by the moving seasonal and occasionally multi-year ice of the transition zone.

Extensive research and monitoring programs carried out throughout the period from 1972 to the present on these islands leads industry to be confident in its ability to successfully build and operate production islands in this region.

Similar successes have been experienced in other fields of endeavour, such as Arctic shipping and pipelining, and were also reviewed in earlier editions of the **Beaufort** magazine.

The industry planned, built and currently operates a support services network along the Beaufort Sea coastline. This includes a major support base at Tuktoyaktuk, a winter resupply and moorage basin at McKinley Bay, airfield facilities, docks and wharves, and a



*The first exploration island in the offshore Beaufort Sea was built in 1972. Since then 21 artificial islands have been constructed. Most of the earlier islands used slope protection materials such as sandbags to protect their upper slopes from wave and current erosion.*



*The Tarsiut island, located in 22 m of water, was the first island built with caissons to penetrate the waterline and to resist first-year ice forces.*



*In 1982 a single steel caisson known as the SSDC was brought into the Beaufort and was ballasted down onto a subsea berm located at the Uviluk drillsite in 31 m of water.*

sophisticated communications network. Part of the support network is a fleet of aircraft and marine vessels, including icebreakers and specially reinforced drillships.

In order to operate efficiently and safely, the industry has conducted extensive research on many aspects of the Arctic, including its physical and biological characteristics. In fact, the design of oil production systems, as well as operational procedures to go with these systems, has always placed a high priority on industrial and environmental safety. Before addressing those specific research and development aspects, a brief outline of the geography and climate of the region is appropriate.

### Climate and Geography

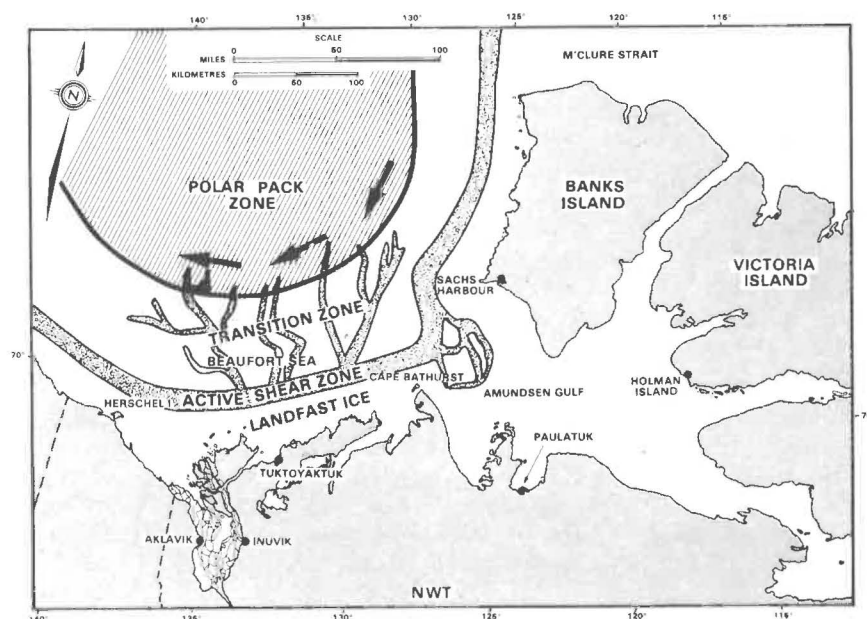
The entire region is above the Arctic Circle, with summertime temperatures averaging only 6 degrees Celsius, dropping to a cold average of minus 30 Celsius during a nine month winter which experiences about a month and a half of virtually total darkness. Offshore, ice is present for most of the year, generally melting away between July and October near the coastline, and in the transition zone between the landfast ice and the permanent polar pack. The polar pack fluctuates in location from year to year, although it never totally melts, and in cold years may remain within a few kilometres of the coastline.

The bottom of the Beaufort Sea is part of a continental shelf extending about 150 kilometres off the Tuktoyaktuk Peninsula. When the Industry first entered this region, it

was thought that temperatures below the seabed would be above freezing. In fact, much of the sub-bottom in the drilling area contains permafrost (frozen soil or rock) and is dotted with numerous subsea pingos (ice-cored hills). The sub-bottom has a typical temperature of -0.5 to -2 deg. C, with permafrost in a few locations measuring 700 metres thick. The pingos range in diameter from 300 to 1,000 metres, and some rise to within 18 metres of the ocean surface, constituting a hazard to navigation for deeper draft vessels.

The coastal waters of the Beaufort Sea are fairly shallow, rarely exceeding 100 metres in depth. Since large floating ice floes have deep keels, in some areas the seabed is frequently scoured, particularly in water depths around 25 metres. Given this feature, industry employs techniques to prevent damage to subsea installations such as blowout preventer stacks during the ongoing drillship exploration program. Similar consideration will be given to the design and construction of future installations.

The Beaufort Sea area is characterized by three main types of ice. In the nearshore area the ice becomes landfast and is therefore relatively stable. Far offshore is located the permanent polar pack which is constantly moving in a generally clockwise direction. In between is the transition zone, where moving ice constantly grinds against the stationary landfast ice. During the summer months, the landfast ice melts away and the transition zone clears, to permit drilling in this area.



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*Approximately 1,800 polar bears are estimated to live in the Canadian Beaufort, a number which seems to vary from year to year depending upon the abundance of ringed seals. (Courtesy Northwest Territorial Wildlife Service).*

## Wildlife in The Region

The Beaufort Sea, and Arctic waters generally, support fewer species of fish and mammals than do temperate oceans. On an annual basis, there is less sunlight than in more temperate zones, and below the sea ice even less sunlight penetrates, with much of it being reflected back into space. There are also wide variations in climate from year to year, resulting in corresponding variations in ice conditions and general wildlife populations.

Animal species in this region have adapted to change, exhibiting migration, feeding and breeding patterns that complement the seasonal swings. The most significant marine mammals inhabiting the Beaufort Sea are ringed and bearded seals, white whales and bowhead whales. The seal species live in the region throughout the year, with ringed seals preferring the coastal landfast ice areas during the winter months, while bearded seals generally remain offshore in the transition zone, where ice is constantly moving.

Whales are only present in the region during the few open water months. Each spring by about May, they enter the Beaufort Sea from the west, generally following open water leads in the pack ice. White whales, numbering from 3,000 to 7,000, make their way to the

Mackenzie estuary where they are believed to, amongst other things, rear their young in the warm turbid waters of the Mackenzie River. It is also here that they are hunted every year by the local Inuit who still prize the muktuk. By the end of July, the whales begin to disperse offshore, eventually proceeding westward again as fall approaches. The much larger and less common bowhead whales, on the other hand, usually stay well offshore, with total numbers of roughly 750 having been estimated to occur in the large area where the drillship fleet operates. Hunting of bowhead whales is prohibited in Canada,

although they are harvested by the Inuit of Alaska both in the spring as they enter the Beaufort Sea and in the fall when they leave.

Other mammals inhabiting the offshore area include polar bears and Arctic foxes. Approximately 1,800 polar bears are estimated to live in the Canadian Beaufort, a number which varies from year to year depending upon the abundance of ringed seals. Although they spend most of their time roaming on the sea ice in search of seals, they den mainly onshore on Banks and Victoria islands.

Arctic foxes are mainly terrestrial, but hunt in the winter months on the coastal ice for ringed seal pups. They also scavenge on the remains of polar bear kills, illustrating one of the interrelationships among Arctic biota.

On land, the largest and most economically important mammals in the coastal area are the three sub-species of caribou, namely reindeer, barren-ground caribou, and Woodland caribou. The well-known Porcupine caribou herd, of barren-ground caribou stock, frequents the northern Yukon, where it would be expected to interact to a limited extent with development facilities for that area. The domesticated reindeer herd, on the other hand, occupies the reindeer grazing reserve where several industrial activities in-



*The Mackenzie Delta and coastal regions of the Beaufort Sea and Amundsen Gulf are the summer home of many species of birds including snow geese shown here.*



*Each summer beluga whales (white whales) come into the Canadian Beaufort Sea, where they make their way to the shallow, warm waters of the Mackenzie estuary.*

cluding exploratory drilling operations have already taken place. Other important terrestrial mammals to the local harvesting economy are muskrat, wolves, black and grizzly bears, and moose.

The Mackenzie Delta and coastal regions of the Beaufort Sea and Amundsen Gulf are the summer home of literally millions of seabirds. Species such as the yellow-billed loon, yellow wagtail and bluethroat have their entire Canadian breeding population in this area. Snow geese have the largest concentrations of nests in the region, with as many as 198,000 nesting individuals having been observed in just one snow goose colony on Banks Island. Other important species include brant, oldsquaws, eiders, phalaropes, jaegers and murre. These migratory offshore species rely upon open water patches during spring break-up for resting and feeding areas. Hundreds of thousands of birds can be seen congregating in such areas at this time and, in heavy ice years when open water is rare, thousands have been known to die of starvation.

Although some 43 species of fish inhabit the Beaufort Sea area, the most commonly harvested types, such as Arctic and least cisco, Arctic char, inconnu and herring occur mainly in the nearshore waters. Bot-

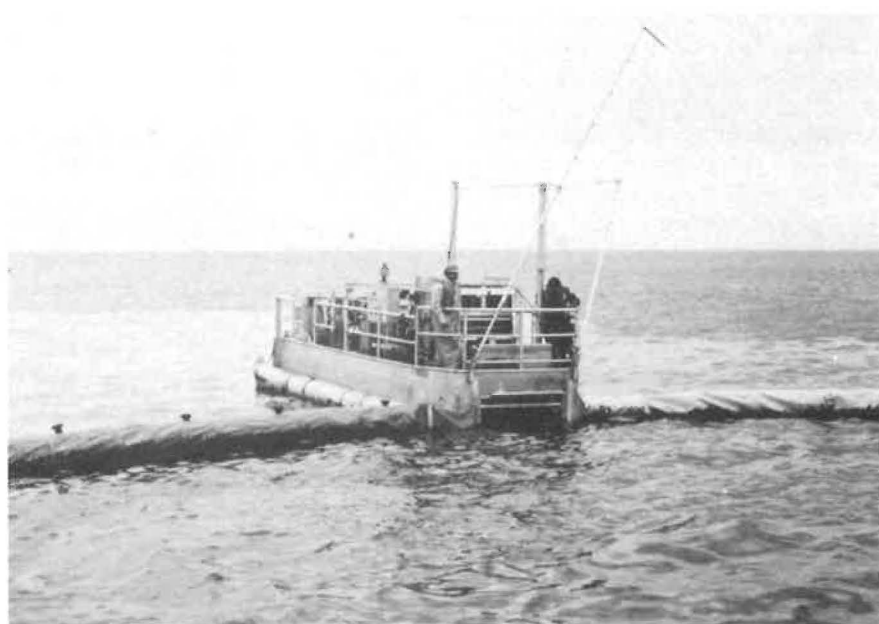
tom dwelling invertebrates include small marine worms, clams, snails and crustacea such as amphipods and mysids. None of the larger species common to more temperate waters, such as Alaska and Dungeness crabs, prawns, shrimp, mussels, or oysters, are found in this area.

Based on substantial environmental research and monitoring programs undertaken to date by both industry and government, few

significant environmental problems have resulted from the exploratory phase of oil industry operations in the region. Nevertheless, several major concerns remain, some of which will be highlighted.

## Oil Spills and Countermeasures

One of the greatest concerns related to hydrocarbon development in the Beaufort Sea-Mackenzie Delta region is the threat of a major oil spill. To address this concern, industry had instituted measures intended to prevent the occurrence of spills. This is seen in all phases of operation ranging from the use of blowout preventers during drilling operations to the quick disconnect systems employed by drillships, to the sophisticated systems being used to detect and forecast ice movements. Beyond the primary line of defense industry recognizes that both minor and possibly major oil spills can occur and it has therefore conducted considerable research in the fields of oil spill behavior and cleanup in Arctic environments. New kinds of equipment, specially tailored for use in Arctic conditions, have been developed and added to the more conventional counter-



*The Beaufort Sea area has direct access to the largest and most up to date arsenal of oil spill countermeasures equipment in Canada, including a newly developed Arctic skimmer.*



measures available to deal with a spill. The Beaufort area now has direct access to one of the largest and most up to date arsenals of oil spill countermeasures equipment of any site in Canada. Included are conventional and Arctic booms, conventional and Arctic skimmers, and a large pollution control and cleanup barge equipped with burners to incinerate oil. Oil absorbant materials and oil spill dispersants are also kept on hand. In addition, prototype work has been completed on fireproof booms, heliportable incinerators, and air deployable igniters - and a great deal of work had been done to learn more about how oil behaves in ice and how it may be cleaned up under ice-bound conditions.

To complement this equipment, computer trajectory models have been developed to assist in predicting where oil from an offshore spill may move over time. Furthermore, the physical and biological features of the entire coastline of the Canadian Beaufort Sea region have been mapped and the data are available to the OnScene Commander in the form of resource sensitivity maps and colour video tapes.

Comprehensive contingency plans have been developed, based on industry's ability to predict where

spilled oil may move due to winds and ocean currents, its knowledge of the biology and geography of the region and the capabilities of available countermeasures equipment. These plans will continue to be modified and improved in the future as new information becomes available, and as operations expand to include production activities.

The foregoing discussion is not intended to imply that major oil spills,

should they occur, would not cause environmental damage - but we do believe that industry has systems and operational plans to minimize the chances of such a spill occurring. Furthermore, the industry has adopted a progressive attitude towards oil spill research and the development of technologies and contingency plans to assist in clean-up, with the ultimate objective being to minimize environmental impacts to the greatest extent possible.



(Top and Above) Air deployable igniters have been developed which can be dropped from aircraft such as helicopters onto oil spilled on the sea or in ice. The igniters will be particularly effective in dealing with oil spills should they occur in remote areas.

## Environmental Effects of Normal Activities

Notwithstanding the great concern over major oil spills, it should be emphasized that they are the least likely to occur. Other activities related to exploration and development are both ongoing and immediate: activities such as drilling, dredging, construction both on and offshore, and transportation whether by trucks, marine vessels, or aircraft.

As a consequence of offshore drilling exploration, and in the future production operations, discharges of sewage, heated cooling water, drilling muds, and produced waters will take place daily. In accordance with government regulations, the industry employs oil-water separators, sewage treatment systems, and other technologies intended to reduce the quantities of contaminants discharged to the environment. Beyond this, industry and government studies on the effects of waste discharges from drilling operations on the environment have generally shown that effects, if they occurred at all, were usually highly localized and minimal. The use of advanced treatment technologies in the future, combined with com-

prehensive pollution monitoring programs, will ensure the continued well being of the northern environment.

Another regular activity to be carried out in the region, both now and in the future, will be dredging. Dredges will be used to build islands, to create harbours and navigation channels for shipping, and to dig trenches for submarine pipelines.

Dredging removes and relocates seafloor sediments. This causes the localized and short-term suspension of sediments into the water column. Small organisms living in seafloor areas subject to dredging or burial by excavated materials will be destroyed. However, studies conducted in the Beaufort region have shown that the damaged areas are recolonized very quickly by bottom dwelling species. The more mobile animals, such as amphipods, isopods and bottom fish, have been found to move in within days, if not hours. Other animals such as clams and worms return more slowly, but overall, populations appear to recover to levels resembling their former abundance and diversity within about 3 years.

Monitoring of present dredging activities, not only in the Beaufort but in other river deltas around the

world, has revealed that relatively few fish are captured in dredge pipes; the majority of these are bottom dwelling species. In the Beaufort region, the fraction of seafloor which is or will be disturbed, in relation to total habitat available for fish and other organisms is, and likely will remain, very confined.

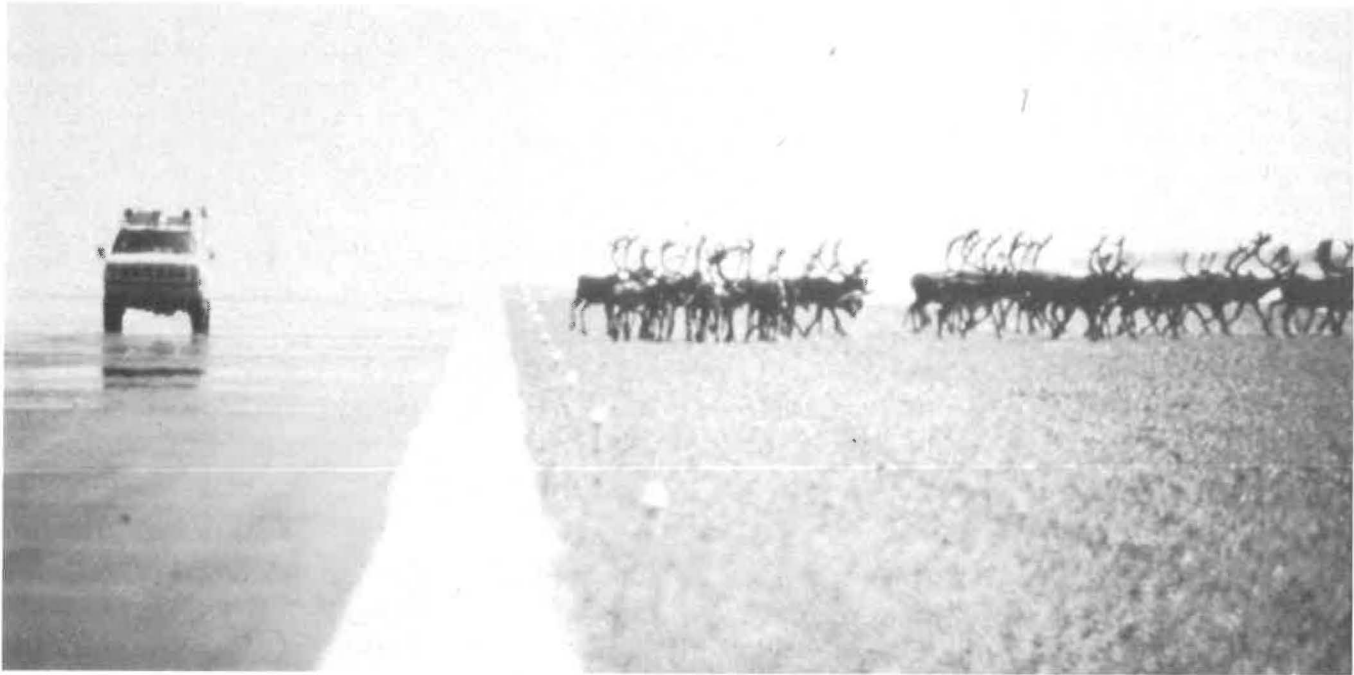
Concerns have been expressed regarding transportation related activities between ships and whales, aircraft and birds, and truck/roads and caribou. Each summer for a decade now, the industry has been monitoring the behavior of white whales, and more recently bowhead whales, in order to evaluate, and if necessary, employ measures to minimize possible impacts to these species. Although whales have occasionally been frightened the impact has been temporary and localized. The aerial monitoring programs have been very successful in reducing possible interactions, thus ensuring that the whales continue to migrate into the region and carry on with their normal activities.

Much of the lowland coastal Beaufort region serves as staging and nesting grounds for a variety of seabirds and other waterfowl. Several bird sanctuaries are located in the region. There is concern that helicopters and fixed wing aircraft operating between shorebases and offshore platforms may cause considerable disturbance to these and other kinds of birds. However, industry aircraft are required to comply with recommended aircraft altitude and routing restrictions as much as possible. In this way, impacts on birds have generally been minimal to date, and similar results would be expected in the future.

Few roads presently exist in the Beaufort region and those that do serve only local areas. Indeed most vehicular traffic involving trucks from the south takes place during the winter months. They travel along the Dempster Highway to Inuvik, where they transfer to ice roads over the frozen Mackenzie River and Beaufort Sea ice to places such as Tuktoyaktuk and McKinley Bay. Although not required by in-



*Dredges will continue to be used to build islands, create harbours and navigation channels for shipping and to dig trenches for submarine pipelines. Although dredging activities disrupt sea bottom habitat, impacts will be localized and recovery of the benthic biota will occur relatively quickly.*



*Research results of caribou responses to roads such as those near Prudhoe Bay and the Dempster Highway indicate that direct impacts due to roads are generally minimal. However, roads do create access, which may result in overharvesting of the resource unless sound resource management programs are employed.*

dustry it is possible that all-weather roads may eventually be built to link the Dempster highway with existing or proposed shorebases. The construction and use of these roads raises concerns for terrestrial mammals such as caribou. Research results of caribou responses to the Dempster Highway and experience from developments in the Prudhoe Bay area of Alaska indicate that roads themselves do not appear to cause much of a problem for caribou. However, roads into new areas will provide greater access - this in turn raises the potential of increased harvesting - perhaps overharvesting. Assuming one or more roads are built in the future, government, industry and the public will have to work together to produce a sound resource management plan intended to ensure the continued wellbeing of species such as caribou for the benefit of all.

As one can appreciate, the foregoing discussion on environmental effects in the Beaufort Sea-Mackenzie Delta region has only touched on some of the more important concerns. It is impossible to

cover all of them at this time. That is the purpose of the Environmental Impact Statement, which interested readers are encouraged to review.

### Development and the People

The Beaufort Sea region is home

for roughly 7,000 people, more than half of whom are Inuit, Dene or Metis. Many of the native residents continue to rely upon the land and its wildlife for subsistence, maintaining a fairly traditional way of life which is heavily based on the region's natural resources. Resource har-



*Many of the native residents continue to enjoy traditional pursuits such as hunting and fishing which must be protected as the region develops in the future.*

vesting, although supplemented by wages for many, is still the backbone of the income and lifestyle for communities like Arctic Red River, Paulatuk, Aklavik, Sachs Harbour and others.

Many native people have successfully combined aspects of both traditional and modern lifestyles, combining wage employment with hunting, trapping and fishing. In today's north, the wellbeing of the traditional sector is not independent of the industrial sector. Earnings

from industrial employment provide the cash for equipment purchases to sustain or increase productivity in the more traditional pursuits. Industry has also played a role in providing alternative work for people on the land. It has helped place the renewable resource sector on a more commercial footing with purchases of reindeer and Arctic char from regional suppliers. Industry has thus grown to be an integral part of, and indeed an important foundation for, the economy of

the region.

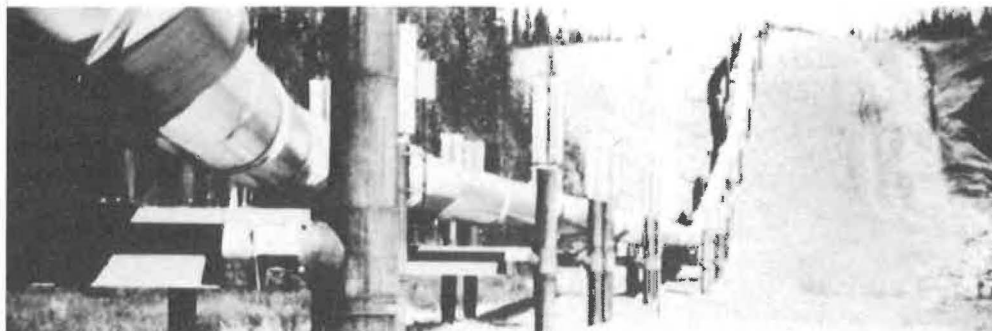
Future hydrocarbon development will produce increased opportunities and options for employment, skill upgrading and financial security. On the other hand, there are impacts of industrial development which are a cause for concern and which require close liaison and understanding between industry and community groups. For example, centres such as Inuvik, and to a lesser extent, Tuktoyaktuk are forecast to experience considerable population growth between now and the year 2000. This could bring strains on the quality and availability of local services and stresses in personal, family and community relationships. The degree to which growth would intensify problems at the community level would depend, to some extent, on how carefully the social aspects of such growth were planned and conducted. This will require a continuing cooperative effort with participation by the public, government and industry interests.

Over the years that it has operated in the north, industry has established a good rapport with the local communities. The understandings that have developed must continue to be built upon. The industry has fostered business and employment opportunities for those who wished to participate, while at the same time enacting programs to protect traditional lifestyles for workers wanting a mix of both wage and resource based earnings. Training and upgrading programs have been developed for those northern residents interested in advancement in the industry. These and other programs will continue in the future.

The industry has many years of experience in the Beaufort and would like to build upon its track record in community liaison and social action programs. It has worked closely with the residents, government agencies and native organizations to minimize impacts and maximize the benefits of its presence on the north. This rapport will continue to be an important vital ingredient in the future as development plans unfold.



*Future hydrocarbon development will produce increased opportunities and options for employment, skill upgrading and financial security. (Courtesy H. Palmer).*



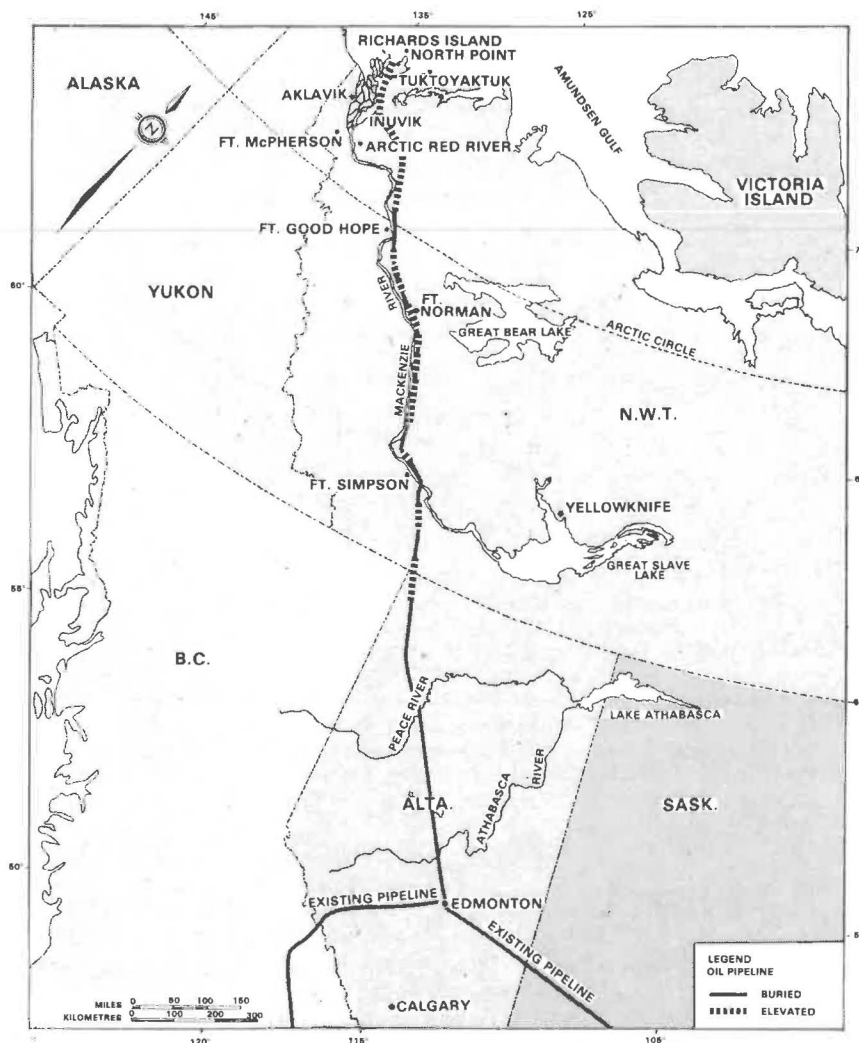
Assuming a large diameter pipeline is built, in permafrost areas the pipeline will be mounted on vertical support members to protect the frozen terrain.

# PIPELINES AND THE MACKENZIE VALLEY

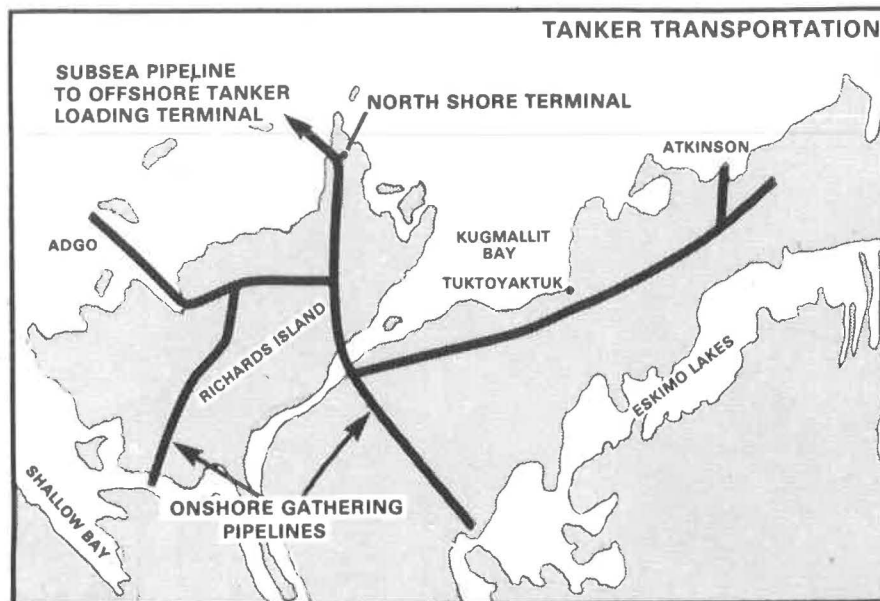
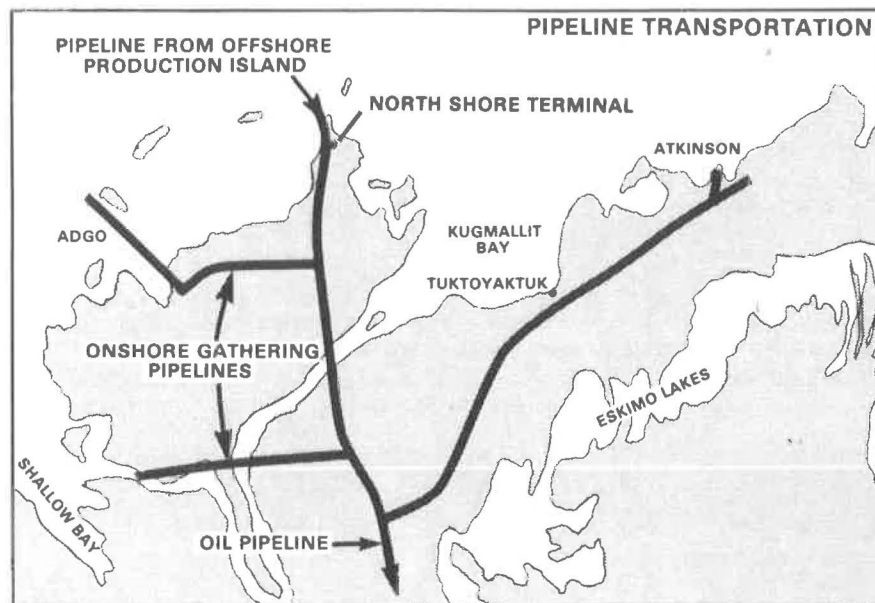
In order to develop the Beaufort Sea-Mackenzie Delta hydrocarbon reserves, pipelines will play a very important role. Small lines will be used to collect and transport oil or gas from individual wells or well clusters to central processing facilities; some will be subsea, others will be overland; and still other larger pipelines are being considered to transport oil and later on, gas, to markets in southern Canada.

A range of pipeline sizes are being considered by industry for transporting oil from the region to the marketplace. To assess the greatest possible impacts a large diameter pipeline 42" (1.2 metres) was examined in the Environmental Impact Statement. However, to begin transporting oil through a pipeline at the earliest possible date, it may be that a smaller pipeline could be built first. For example, to deliver smaller quantities of oil from onshore or nearshore oil fields during the early years, a 12 - 16" (30 - 40 cm) buried pipeline could be built, to connect to the now approved Norman Wells pipeline. As larger reserves are proven, the line could be looped to further increase capacity. If sufficient reserves are found, a larger diameter pipeline may eventually be built.

Because of settlement that could occur in permafrost areas, a large pipeline could be elevated over



The pipeline connecting the Beaufort Sea-Mackenzie Delta to existing systems would be approximately 2,250 kilometres in length.



Whether oil is transported to southern markets by tankers or by pipelines, gathering lines will be required to collect and transport oil and gas from individual wells or well clusters to central processing facilities before being directed to the transportation system.

about one third of the total length of 2,250 kilometres from the Beaufort Sea to Edmonton, Alberta. The elevated sections would be supported by vertical support members and the pipe would be insulated. Small diameter lines could likely be buried for their entire length.

The planning for a pipeline must address the substantial build-up in activity that peaks with construction, followed by a similar decline in activities as the pipeline becomes operational. It is estimated that a pipeline up the Mackenzie Valley to Edmonton would take about four

years to construct, with much of the work being accomplished during winter. Summer activities would include the building of north and south terminals for the line, pumping stations and the completion of river crossings. Temporary facilities such as wharves, airstrips, work camps and access roads must also be prepared, and materials and machinery would need to be stock-piled along the pipeline right-of-way. It is estimated that at the peak of activities, about 13,000 people could be employed on pipeline construction. Once the line became operational, the number of full-time employed would drop to about 200, growing again to about 300 by the year 2000 as the number of pump stations required increased. In building a pipeline, the impact of pipeline construction and operations upon the residents of the Mackenzie Valley region, the many forms of wildlife, and the general environment are essential considerations. The following parts of this article will examine some of the more important factors.

## Climate and Geography

The average annual temperature of the Mackenzie Valley region is well below freezing, and much of the ground is frozen permafrost. In the north, along the Beaufort Sea coastline, the permafrost may be up to 700 metres deep, while more central and southern regions of the 2,250 km corridor have discontinuous permafrost.

The climate and terrain are important factors in the construction of a pipeline to carry oil to southern Canadian markets. The pipeline corridor from the Beaufort Sea to Edmonton, Alberta would generally follow the "easiest", most gently sloping terrain, although it would cross areas of rolling hills and some steeper slopes, particularly at river crossings. The pipeline would have to make three major river crossings. From north to south they would be located at the east channel of the Mackenzie River in the Delta; the Great Bear River near Fort Norman;



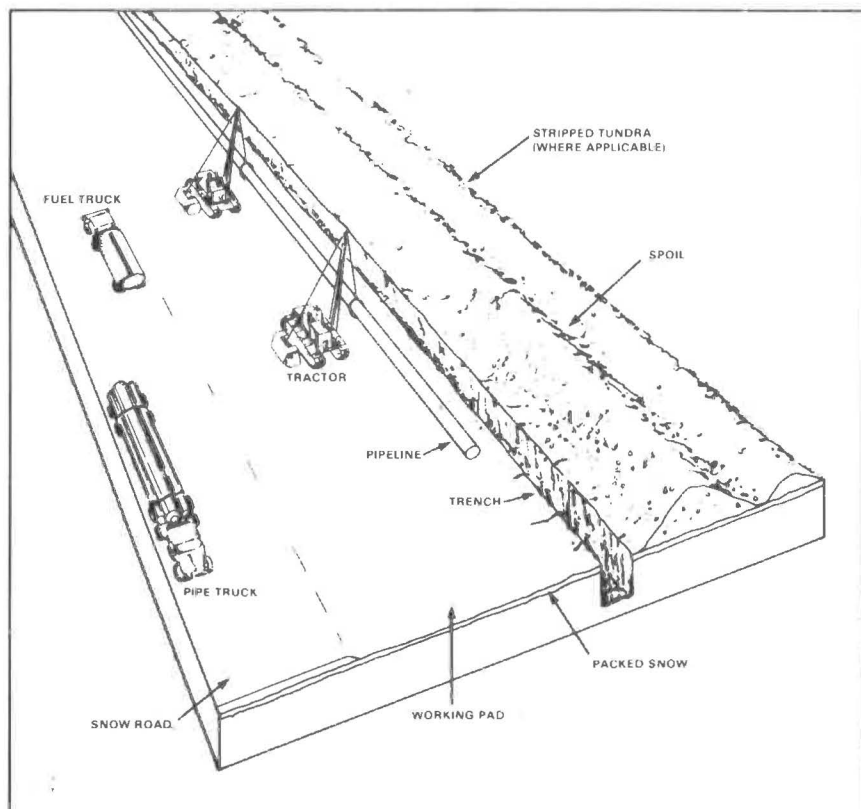
*Prior to pipeline construction, a pipeline right-of-way must be established and the vegetation cleared away.*

and the Mackenzie River upstream from Fort Simpson.

### Environmental Aspects of Construction

Based upon experience gained with other pipelines such as the Trans-Alaska Pipeline, most environmental impacts related to pipeline construction are expected to occur during the construction phase. Once completed and operational the environmental impacts are predicted to be minimal. Pipeline trenching, construction and installation will be accomplished mostly in the winter months when the terrain is frozen, and damage to soil cover and vegetation can be minimized. To protect permafrost terrain snow and ice work pads will be used.

Prior to pipeline construction, a right-of-way must be established. As with any pipeline, there will be some local modifications to terrain and soil, drainage conditions and the physical appearance of the right-



*Buried pipelines in permafrost regions will be installed using snow roads for temporary access and snow work pads to minimize disturbance of the natural terrain.*



*Experience with the Trans-Alaska Pipeline suggests that most impacts related to pipeline construction and operation will be transient and generally minimal.*

of-way. Impacts will be most noticeable during the construction phase. The effects of pipeline construction on the terrain will be minimized by using drainage and erosion control measures common to the industry and proven successful under Arctic conditions.

Water quality and stream flows will be affected by pipeline construction at river crossings. These effects, although transient, will be minimized by use of appropriate measures. Disturbed areas will be revegetated.

### **Wildlife and the Pipeline**

Whenever and wherever possible, pipeline routing and construction activities will avoid sensitive or preferred wildlife habitats that might be damaged by short term, but in-

tense human activities. Disturbances caused by blasting, aircraft overflights, vehicle traffic, and other general construction activities will be confined mainly to the immediate vicinity of the right-of-way and for only relatively short periods of time. This may result in some temporary disturbance to mammals such as reindeer, caribou and moose. However, experiences with the Trans-Alaska Pipeline suggest that these types of impacts will also be transient and generally minimal.

The influence of construction activities on the domestic reindeer herd in the Mackenzie Valley Grazing Reserve, the Bluenose caribou herd located east of the right-of-way, and Woodland caribou to the west are forecast to be minor and short-lived. Neither Bluenose nor Woodland caribou are common in the vicinity of the proposed right-

of-way. At the northern end of the pipeline, the domestic reindeer herd's movements can be readily planned for, and accommodated, especially since only a very short portion of the line is involved.

Grizzly and black bears are unlikely to be affected by much of the construction activities, since they hibernate in winter when the major construction will occur. The main concern is the tendency of bears to be attracted to garbage, and to human habitation along the right-of-way. In any case, black bears are widely dispersed, and grizzly bears are present primarily in the northern sections of the Mackenzie Valley region. The many other mammals inhabiting the region, including marten, muskrats, beaver, lynx, wolves and foxes are considered to be rather insensitive to most habitat disturbances which may be caused

by pipeline construction, or are so widely dispersed through the region that only a very small percentage of the total population could possibly be in the vicinity of the pipeline at any given time.

Many of the pipeline construction activities will take place during the winter months when most of the 170 species of birds recorded in this region will not be present. The right-of-way for the line will be selected as much as possible so as to avoid river habitats favoured by swans, geese and other waterfowl, and nesting areas for raptors such as eagles and hawks. Likewise aircraft will comply with altitude and route guidelines whenever possible to minimize impacts on birds.

Prime fish habitat will be avoided by minimizing the number of stream and lake crossings, and by building the pipeline across small streams and rivers during winter months.

However, even with the most stringent application of avoidance and other mitigative techniques, some fish or fish habitat will be damaged by pipeline construction. The condition of some habitat will deteriorate at least temporarily, but in relation to total aquatic habitat and the general distribution of fish and other aquatic biota, impacts will be minimal.

### Safety Considerations

The safety record of pipelines as a way of transporting oil has been excellent. Leak detection systems are employed in all new pipelines and serve to automatically shut down the line before a significant quantity of oil could spill. This is an essential safety feature since a large oil spill might damage vegetation and wildlife habitat over a substantial area.

Although oil spills are unlikely, should the pipeline leak or rupture on land during the summer, the resultant spill would most likely be contained by trenching and berming. Following this, the oil would be pumped into temporary storage bladders for reinjection into the pipeline and residues collected for safe disposal. To keep terrestrial wildlife from becoming oiled, spill areas on land could be isolated by fencing. If a spill were to occur in winter, oil would be expected to penetrate the snow but not the frozen soil beneath. Such oil spills could be burned off or removed with mechanized equipment. An oil spill into a major river such as the Mackenzie would be rapidly diluted due to the river's massive flow.

Evaporation of some of the oil and oil spill clean-up measures would help to reduce the impact of the spill. Containment booms and



*The Mackenzie Valley is an important flyway for many species of birds including these snow geese. (Courtesy J. Kristensen LGL Ltd.)*

recovery systems would be deployed to capture and recover oil spills in open water areas wherever possible. If a spill were to occur under river ice, the lost oil could be concentrated by cutting channels in the ice downstream of the spill. Oil collected in these channels could be burned off in the established manner.

## The People

Just over half of the population of the Northwest Territories resides in the Mackenzie Valley and Great Slave Lake region. With the exception of the larger population centres such as Yellowknife and Hay River, most of the residents are Dene or Metis. The construction of an oil pipeline would have an important



*Pipeline construction activities will provide employment for much of the regional work force.*



*The industry and people of the region have many years of experience in connection with the development of the Norman Wells field. This should facilitate the orderly development of a pipeline system to the Beaufort Sea.*

impact upon many communities in the Valley region, particularly larger centres such as Norman Wells, Yellowknife, Fort Simpson and Hay River.

Transportation requirements and pipeline construction activities would provide employment for much of the regional work force, although mainly on a seasonal basis, and mostly during the three to four year period that it would take to construct a pipeline. Once a given pipeline was completed, several hundred jobs would remain available for ongoing work along the line.

Most socio-economic impacts caused by pipeline construction are expected to be short-term. Communities along the right-of-way will experience a growth in local business activities and revenue, coupled with increased employment. This would understandably decline once the pipeline was in operation. During the construction phase, as well, there would be substantial increases in truck, barge and aircraft movements along the Mackenzie Valley.

The industry, in cooperation with government and the people of the region, will have to ensure that vital supply services to the communities will not be adversely affected by the surge in its transportation requirements. Effective liaison between the pipeline builders and the communities will be required to ensure optimum regional and local participation in the employment and business opportunities generated by pipeline activities. Ongoing research will address these, and other socio-economic issues which bear directly upon pipeline construction. The many years of oil industry experience in the north, and the well-established communications with various social, community and government organizations, will facilitate the orderly development of a pipeline system. This will ensure that adverse aspects will be minimized while benefits maximized for all Canadians, and particularly for the local communities and people of the Mackenzie Valley region.

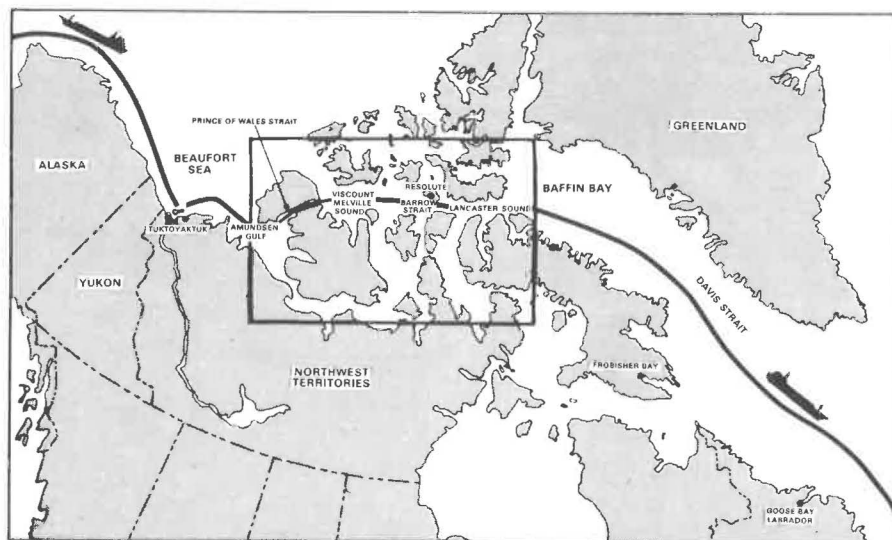


*Future Arctic Class tankers will incorporate many design features such as enormous strength and double hulls for resisting ice, twin and independent propulsion systems, an inert gas system, and advanced navigational aids, all of which will combine to make these vessels among the safest in the world.*

## Arctic Tankers Through the Northwest Passage

Besides pipelines, Arctic Class icebreaking tankers are also being proposed to transport hydrocarbons from the Beaufort Sea region to the marketplace. Arctic tankers are considered to be especially attractive in servicing prospective deepwater oil fields of the offshore Beaufort Sea. At these locations initial development costs will be much greater than for onshore fields, and the initiation of early cash flows will be crucial to their development.

Although Arctic Class tankers do not yet exist, the oil industry's six years of progressive experience in the Beaufort Sea with ice-reinforced drillships, ice class supply vessels and icebreakers such as the Kigoriak, have provided a wealth of



*The route an Arctic tanker will follow is illustrated in this map. Eastbound tankers will generally travel through Prince of Wales Strait, Viscount Melville Sound, Barrow Strait, and Lancaster Sound, following along the east coast of Canada around Newfoundland.*



*The Robert Lemeur, a Class 3 icebreaker was added to the Beaufort Sea fleet in 1982. Shown here leading a drillship back to its winter anchorage, the icebreaker incorporates several new features which are being considered for use in future icebreaking tankers.*

valuable data which are being used in the design of these ships of the future.

The newest addition to the Beaufort fleet, namely the icebreaker Robert Lemeur, incorporates several more novel items under consideration for future Arctic tankers, and indeed is serving as a 1/4 scale test prototype for features such as the oil storage compartments, twin screw propulsion system and others.

To test the Arctic tanker concept further and to begin moving early oil to market from offshore Beaufort Sea fields, industry is proposing to construct and operate a smaller Arctic Class ship of approximately 80,000 Deadweight Tonnes. This ship would also undergo extensive testing and evaluation and would serve to demonstrate the feasibility and safety of full-scale Arctic tanker transportation involving larger vessels in the 200,000 DWT category.

These larger Arctic tankers will still be modest in size by comparison with the largest conventional oil tankers sailing in temperate waters, but will be more powerful than any tanker or icebreaker ever built. They would incorporate many unique features to allow safe year-round operation in the Arctic seas of the Northwest Passage. Concerns have been expressed about Arctic tankers in regards to possible environmental impacts in the Arctic region

generally and particularly in the Northwest Passage where they would travel. These concerns are valid and need to be addressed, but often overlooked is the fact that the Arctic islands of Canada, and various channels and straits of the Northwest Passage region already have substantial marine traffic annually, albeit of a seasonal nature, including ships carrying fuel and supplies to small northern coastal settlements.

## History of Traffic

Although the Northwest Passage

has been travelled by vessels since the early 19th century, and is traditionally the route marked by a western entrance at Amundsen Gulf and an eastern entrance at Lancaster Sound, there are, in reality, several northwest passages. The first successful trip through the Canadian Arctic islands was accomplished via a southern routing, beginning at Lancaster Sound, sailing close to the Canadian mainland, and entering Amundsen Gulf via Dolphin and Union Strait.

There is also another routing which vessels have taken, bypassing Lancaster Sound completely in favour of a narrower entrance called Fury and Hecla Strait. In addition, at the western end, vessels travelling eastward may sail through Prince of Wales Strait, east of Banks Island or, if ice conditions allow, through M'Clure Strait, north of Banks Island.

The most common routing for the Northwest Passage, however, is the most direct route. From the west, it starts at Amundsen Gulf and proceeds eastward through Prince of Wales Strait, Viscount Melville Sound, Barrow Strait, Lancaster Sound and then to southern waters via Baffin Bay and Davis Strait. This is the primary route proposed for future Arctic icebreaking tankers.



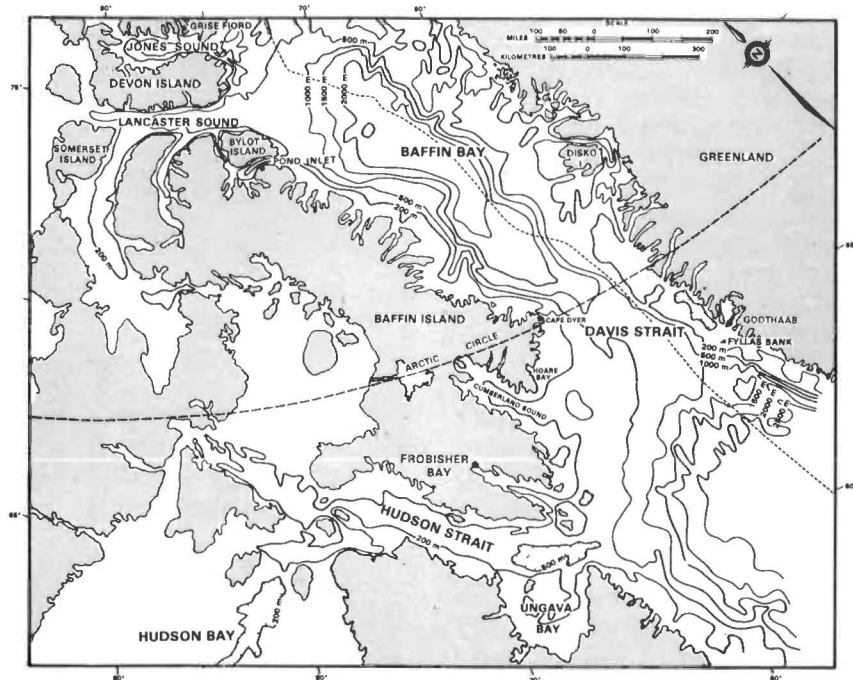
*The S.S. Manhattan, shown here being accompanied by the John A. Macdonald Coast Guard icebreaker was the first oil tanker to successfully transit the Northwest Passage.*

## Labrador, Sea Dragon, Manhattan, Kigoriak, and Others

Many vessels have travelled the Northwest Passage via one or more of the various routes described previously. Roald Amundsen, with a 47 ton fishing vessel, took more than two years to travel from east to west. The RCMP boat, St. Roch, also made passages in both directions in the 1940s. However, the first large, modern vessel to make it through was the Canadian Coast Guard icebreaker, Labrador, in 1954. Nuclear submarines have navigated underneath Arctic ice since the 1950s, and in 1969 the U.S.S. Sea Dragon travelled westward through Lancaster Sound submerged, and exited via M'Clure Strait, on a journey to the North Pole.

That same year the first tanker, the specially modified S.S. Manhattan, escorted by the John A. Macdonald icebreaker, made a record setting east to west and west to east round trip through the Passage. In 1970 the 106,000 DWT, 300 metre long oil tanker repeated this feat, thereby demonstrating the feasibility of deep draft icebreaking traffic in the Canadian Arctic. Since then other records have been set in Arctic navigation. The Russian ship Arktika, the most powerful nuclear icebreaker in the world, has sailed right to the North Pole, and Dome's icebreaker, Kigoriak, has established another first by operating year-round in the Beaufort Sea region.

The summertime resupply of small Arctic settlements in the Canadian Archipelago is accomplished mainly by ships. However, none of those now carrying fuel and oil are icebreaking vessels, and therefore they must exercise extreme caution in their movements and the timing of their arrivals and departures in the Northwest Passage region. Due to the variability of ice conditions, and temperatures from year to year, the resupply tankers risk being frozen in, or being damaged by ice floes, unless ap-



*Water depths through most of the Northwest Passage are generally deep enough to accommodate year-round ship traffic. However in certain areas hydrographic surveys will have to be carried out in order to provide a completely mapped shipping corridor.*

propriate planning and caution are exercised.

Nevertheless, the northern communities and industry operations have generally been receiving their winter supplies of fuel without incident or accident. The most notable exception to this has been the Edgar Jourdain, a small coastal tanker which went aground close to the shores of Hall Beach in September, 1980. Several thousand gallons of diesel fuel leaked from the ship over that winter and during the following year. The burn-off of the remaining quantity of the ship's fuels took place in June, 1981, under government supervision, to ensure that no further oil spilled.

### Bathymetry of the Passage

Many vessels routinely sail in Canadian Arctic waters during the brief summer period, but not all channels have been thoroughly surveyed. Some of the waterways, such as Barrow Strait and Lancaster Sound, are well 'mapped', and others such as Davis Strait and Baffin Bay are known to be quite deep

and would not require much further survey.

However, since an Arctic tanker will require water depths of at least 20 metres and adequate channel widths to allow use of the most favourable ice conditions, surveys and soundings of some portions of the passage will be necessary. Some survey data are already being gathered by the Canadian Government Hydrographic Service: for example, at the present time, along a corridor over the Beaufort Sea shelf and through Prince of Wales Strait.

Amundsen Gulf has been surveyed to modern standards and is well-mapped, but Prince of Wales Strait and the nearshore areas along the alternate entrance of M'Clure Strait will require further soundings, as will portions of Viscount Melville Sound.

### Ice in the Passage

Ice conditions in the Canadian Arctic vary widely from year to year. Generally speaking, ice conditions in the Northwest Passage region are most severe around the

north end of Prince of Wales Strait, throughout M'Clure Strait, and Viscount Melville Sound. The highest concentrations of multi-year ice and minimum open water period usually occur in these areas of the passage. In addition, icebergs calved from coastal glaciers are common at the eastern end of the passage, in the mouth of Lancaster Sound and throughout Baffin Bay and Davis Strait.

To cope with variations in ice conditions, including multi-year floes and icebergs, and other climatic conditions, such as 24 hour darkness in winter and storms, the Arctic Class tankers will be equipped with sophisticated navigation and ice reconnaissance systems. These systems will assist vessel commanders in selecting the most favourable routings, avoiding areas of high ice density, while complying with traffic corridors and other restrictions established under federal government authority.

### Icebreaker Tracks

One of the concerns of year-round Arctic tanker traffic is that these ships will break ice and leave a "wake" or ship track in the ice as they travel. During 1981 and 1982, a ship track research program was conducted by industry in conjunction with hunters and trappers of the Beaufort region, using the

icebreaker Kigoriak. One of the main purposes of the study was to determine how quickly the ship tracks refreeze, and can be crossed by hunters on skidoos. The results of the research program have been very encouraging. Under all conditions tested between November 1981 and June 1982, the ship tracks consolidated or refroze very quickly, allowing safe passage on foot usually within an hour and by heavily laden komatik sleds within a couple of hours. Based on research like this, scientists are also predicting that animals such as muskox and Peary caribou, which have been

known to travel from island to island across winter sea ice in the Eastern Arctic, should likewise have little difficulty in crossing a tanker's track through the ice, should they ever approach one.

Another concern expressed about tanker traffic in the Arctic relates to the possibility that ships might cause alterations to the landfast ice zone, especially in Barrow Strait. Significant changes here, should they occur, have been hypothesized to cause measurable changes in the local climate and the distribution and abundance of wildlife species in that area. Specifically, the concern is that tankers may interrupt or alter the normal yearly formation of landfast ice across Lancaster Sound and Barrow Strait, causing the average location of the landfast ice to be located further west than "normal", perhaps leading to earlier spring break-up. However, tests like those conducted during the ship track research program would suggest that effects on the ice regime should be minimal. Furthermore, data examined on natural ice formation and break-up in Parry Channel over the last decade indicate that there is approximately a 400 kilometre variation from east to west in the location of the landfast ice edge border. Thus, it is felt that any changes which may be caused by tanker traffic would likely be very small and, certainly by any measure, well within the wide range of variation imposed by normal climatic conditions.

### Animal Life

Marine mammals such as seals and whales, because of their summer or year-round presence in much of the Northwest Passage, are most likely to be exposed to possible impacts from the normal operation of icebreaking tankers. The highest concentrations of both groups of mammals occur in the western and eastern extremities of the passage; Prince of Wales Strait, Amundsen Gulf and the Beaufort Sea to the west; and Lancaster Sound, Baffin Bay and Davis Strait to the east. The central area of the primary



*This photo illustrates what a ship's captain sees on a typical CRT (cathode ray tube) screen presently in use on a supply vessel in the Beaufort. A similar system would be employed on the Arctic tanker. The left side shows the shoreline of McKinley Bay in the Beaufort, with the right, larger scale image showing the position of the ship in relation to the navigation corridor.*



*The icebreaker Kigoriak sails out of the Arctic twilight during an experimental icebreaker track research program conducted in the winter of 1981/82 in the Beaufort Sea.*



*Narwhals, prized by Inuit for their tusks, are a species of whale that occurs along portions of the shipping corridor.*

tanker route (Viscount Melville Sound) appears to harbour few animals or birds, and whales in particular are absent.

The movement of ships through ice will disrupt some habitat for animals such as ringed and bearded seals, which live amongst the ice. Ringed seals are considered especially vulnerable during the months of March, April and May when they occupy lairs in stable ice and give birth to pups. The young seals are quite vulnerable to Arctic waters for the first month after birth; until they develop their fat layers for insulation against the cold and wet. Although tanker routes would be selected to avoid known areas of congregation wherever possible, some destruction of seal lairs will be inevitable. Fortunately, however, in most areas, the greatest concentrations of birth lairs appear to occur in the shallower nearshore reaches of the coastlines, which large ships such as tankers would not travel through due to depth limitations.

The major concern for whales such as bowheads, white whales and narwhals relates to the underwater noise generated by ships' propellers and the potential for this noise to interfere with the whales' communications and navigation abilities. White whales and narwhals, similar to dolphins and other toothed whales, have highly developed and refined echo-location skills, which they use to

hunt and travel and, it is believed, to communicate with each other. Bowheads, which are members of the baleen family of whales, do not hunt, but rather graze mainly upon plankton in the sea. Their reliance on echo-location appears to be much less important than it is for other types of whales and dolphins.

Much of the concern over underwater noise arises from the perception that because the proposed tankers of the future will be among the most powerful ships ever built, with total horsepower ranging to perhaps 150,000 SHP, they will generate more noise than other ships. However, it is not the horsepower itself that causes underwater noise but rather a phenomenon known as cavitation.

In simplest terms, cavitation is caused when the blades of the propeller are moving rapidly through the water, and in the process creating vapour bubbles that cause noise as they subsequently collapse. The greater the cavitation, the greater the amount of noise created. Also, the greater the cavitation, the lower the efficiency of the propeller. Since the industry is designing these future ships to be as efficient as possible in delivering thrust through the propellers into the surrounding water, considerable research and model testing has been conducted to develop the most efficient propellers possible. Based on field and laboratory measurements, it now appears that these future ships will generate no more underwater noise than that presently being produced by many ships plying the waters of the Beaufort Sea, Eastern Arctic and along the Greenland coast.

Furthermore, observations carried out in the Beaufort Sea over many years have shown that the whales inhabiting this area during the summer months do not appear to have been affected to any measurable degree by present industry activities such as vessel traffic, dredging and island construction operations. Similar responses would be expected to occur in other areas of the Arctic frequented by whales. Nevertheless, further research will be needed to determine conclusively the possible impacts of underwater noise and physical presence of these



*Walrus usually live in relatively shallow waters where they are able to dive to the bottom to obtain clams, shrimp and crabs. (Courtesy Northwest Territorial Wildlife Service)*

ships along the Northwest Passage as they are introduced into the region.

## Tanker Accidents and Oil Spills

Undoubtedly the most conspicuous and often publicized issue with respect to Arctic tankers, although the least likely to occur, are accidents resulting in the spillage of oil. Studies of past oil spills from conventional tankers in more temperate waters have shown that the greatest percentage of tanker accidents around the world have involved ships not owned by oil companies, and most were due to human errors which could be linked to poor training and supervision

and/or management policies. Only a minority of oil spills from conventional tankers were caused by ships belonging to major oil companies. The accident rate of oil company vessels has been many times better than the overall statistical rate. The design of the Arctic tanker has benefited from these previous experiences, having incorporated all important design and safety features identified by the studies to reduce the chances of an accident. The design also benefits from the strength incorporated into the hull to protect the ship from ice and to allow it to operate as an icebreaker. As a result, the chances of an Arctic Class tanker spilling oil following an accident will be at least 120 times less likely than even that

of new conventional tankers belonging to the larger oil companies.

Nevertheless the companies planning to develop the hydrocarbon reserves of the Beaufort Sea recognize that the possibility of an oil spill in the Arctic does exist and, therefore, have contingency plans. The factors which enter into predicting or determining possible impacts of an oil spill, such as timing, location, amount of oil, duration, weather conditions, presence or absence of animals, and so on, make it impossible to state a rule which will apply to all potential accidents and all oil spills. However, based upon previous oil spill incidents and studies, birds have consistently been shown to be the most severely impacted wildlife group when oil spills have occurred. Since the bird population in the Northwest Passage region ranges from sparse to dense depending upon factors such as location and season, should a major spill occur the long range effects upon a particular species would vary widely. The possible impacts of a spill would likely be much more severe in an area such as Lancaster Sound during spring or summer, as an example, than in Viscount Melville Sound, because Lancaster Sound is an important nesting and migration area during the open water period, whereas Viscount Melville Sound supports few birds.

To minimize impacts of an oil spill requires countermeasures and planning. The industry is in the process of determining the shoreline and environmental conditions along the entire route to assist in planning for the location of countermeasures equipment along the route. The equipment which could be deployed, if needed, could include containment barriers, skimmers, portable incinerators, igniters and oil dispersants. Supplies could be located at strategic spots along the passage, where an oil spill might have the greatest impact. In addition, consideration is being given to installing countermeasures equipment on board tankers with personnel trained in their use.



*Several very large colonies of Kittiwakes occur in Lancaster Sound. This and other seabird species would be particularly vulnerable to an oil spill in the unlikely event that one would occur. (Courtesy M. Bradstreet, LGL Ltd.)*



*To assist in contingency planning, surveys are being carried out to map out key coastline features along the shipping corridor. This photo shows the rugged nature of South Baffin Island. (Courtesy G. Greene, ESL Limited.)*

The precautions that will be taken to prevent tanker accidents, the design features of the vessel, such as its double hull and stress monitoring gauges, and the sophistication of its reconnaissance and navigation systems provide the greatest insurance for protection against oil spills. When coupled with training and high safety standards, the chances of an oil spill occurring from an Arctic Class tanker are extremely low.

## Tankers and People

The prospect of icebreaking tankers travelling through the ice-bound waters of the Northwest Passage has raised many concerns for the people of the region and for Canadians generally. Some of the concerns presently being expressed about tankers and their possible impact on the people and wildlife of the Arctic relate largely to fear of the unknown. Not unlike the situation with oil pipelines 10 years ago, most of the big concerns over pipelines have disappeared now that a large oil pipeline has been built and successfully operated in the Arctic and environmental impacts have been found to be minimal. Based on the range of issues examined in the Environmental Impact Statement, the proponents are confident that oil can also be transported safely to market in icebreaking tankers while protecting the environment and other important interests of the people.

However, beyond ensuring that the environment is safeguarded, the industry, in cooperation with the local people, is now beginning to look at ways through which the people may be able to benefit from Beaufort development and tanker transportation of oil through their region.

Some possibilities under consideration include employing people on a rotational work basis at Beaufort facilities and on ships using the Northwest Passage. Still others could be employed in conjunction with environmental research and monitoring programs set up to

evaluate effects as ships begin to travel through the region, and to recommend further protective measures if required. Other options being reviewed include the possibility of supplying fuels for local community use as well as providing assistance with more general com-

munity resupply activities.

Through programs such as these and others which may be identified, it is felt that the people along the shipping corridor can contribute to the development prospects and will benefit in very positive ways as the future unfolds.



*Marine mammals are extremely important to the people of the Northwest Passage. Ringed seals are the most common mammal harvested, although walrus are also taken occasionally. (Courtesy Northwest Territorial Wildlife Service)*



*Pond Inlet, in northern Baffin Island, is one of the coastal communities located close to the shipping corridor. Industry, in cooperation with the people of the region is considering ways to ensure that future development activities provide maximum positive benefits to the region.*

